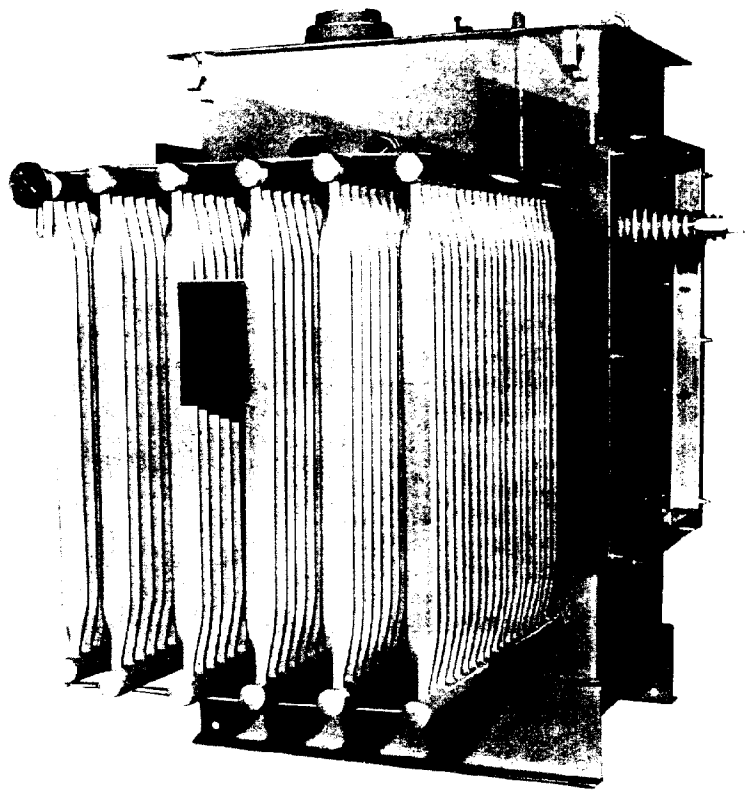
INSTRUCTION BOOK PC-1001
FOR LIQUID-FILLED
PRIMARY AND SECONDARY
UNIT SUBSTATION TRANSFORMERS



Westinghouse Electric Corporation
Small Power Transformer Division
South Boston, Virginia

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SECTION I. TRANSFORMER

INTRODUCTION

These instructions cover the installation, accessories and maintenance of Primary and Secondary Unit Substation Transformers. The Substation Transformer is shipped filled with insulating liquid and as completely assembled as possible. Items shipped detail are those which might become dislodged or cause damage during transit.

Additional Instructions

Copies of instruction leaflets or books referred to but not included with this information can be obtained by contacting your Westinghouse Sales Office.

RECEIVING

All transformers are carefully tested at the factory and are in good condition when shipment is made. However, upon receipt inspect the transformer, packages and parts for possible shipping damage. Also, check the bill of lading for possible shortages. If the inspection indicates a shortage, damage or evidence of hidden damage, it must be reported to the carrier's representative and to a Westinghouse representative before unloading the transformer.

CHECK LIST

External Inspection of Transformer

Blocking and Tie Rods

1. Are all tie rods or chains undamaged and nuts tight?
2. Is all blocking tight and in good condition?
3. Is there any evidence of load shifting in transit?

Transformer Tank and Fittings

4. Are there indications of external damage?
5. Is the paint finish damaged?
6. Are all fittings which were shipped attached still in place and undamaged?
7. Is there any evidence of liquid leakage?

Tank Pressure

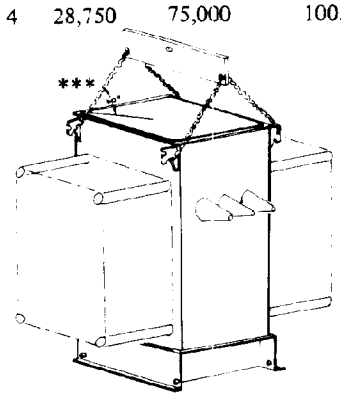
If the transformer when received registers zero pressure on a vacuum-pressure gauge, it could signify a tank leak. However, no definite conclusion is possible until a check is made by introducing nitrogen under pressure and noting whether the increased pressure is maintained without leakage.

HANDLING

Transformers must be handled in the normal upright position unless instructions have been received to the contrary.

Lifting hooks or eyes are provided for crane lifting. When the transformer is lifted, all hooks or eyes must be used. Guides for lifting are contained in the following table.

Chain Size (in.)	No. of Chains Req'd.	Chain Capacity (lbs.)**	Chain Sling Without Spreader Bar	Capacity (lbs.)* With Spreader Bar
1/4	4	3,250	8,400	11,200
3/8	4	6,600	17,100	22,800
1/2	4	11,250	30,000	40,000
5/8	4	16,500	43,500	58,000
3/4	4	23,000	60,000	80,000
7/8	4	28,750	75,000	100,000



*Lifting capacity is the smaller of:
1. Spreader bar capacity.
2. Chain sling capacity.

**ASTM Specifications for alloy-steel chains.

***60^{O} Angle is smallest angle recommended with or without spreader bar.

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Similarly, jacking areas are provided for lifting the transformer with jacks. All such areas must be used when the transformer is to be jacked.

Check the outline drawing for any required special equipment or procedures to be used in lifting.

Never attempt to lift the transformer by using cranes or jacks on any part of the transformer other than the lifting hooks or jacking areas provided for this purpose.

When the transformer is supplied with removable terminal chambers, these may be detached to facilitate moving only the transformer.

STORAGE

Storage in Nitrogen

For those infrequent situations where the transformer is shipped in nitrogen and cannot be installed immediately upon arrival, it is permissible to store for up to three months without adding liquid. For information on storage in nitrogen, consult the factory or obtain Instruction Leaflet 48-069-40.

Storage in Liquid

It is advisable to store the transformer, completely assembled, at its permanent location. In any case, the transformer should be placed on a level, solid foundation. The box containing accessory parts should be stored indoors in a dry location. Indoor transformers should never be stored in an outdoor location without taking steps to prevent accumulation of water on the tank cover and to protect wall-mounted bushings from exposure to direct sunlight.

When stored for long periods, it is recommended that the space above the oil be pressurized with dry air or nitrogen to two or three psig. Then periodic inspections as listed in Section I Maintenance should be made.

Before placing the transformer into service, all checks and inspections listed under "Installation" should be made.

INSTALLATION

Location

Transformers should be placed on a foundation of sufficient strength to support the weight of the unit. The pad should be level. The location of the transformer, whether indoor or outdoor, should provide for adequate accessibility, ventilation and ease of inspection for the unit. The transformer should be at least 24 inches from any obstruction. Location in areas of corrosive chemicals should be avoided.

Connections

WARNING: **DO NOT CHANGE CONNECTIONS ON A TRANSFORMER THAT IS UNDER EXCITATION, NOR MAKE ANY CONNECTIONS EXCEPT AS AUTHORIZED BY THE NAMEPLATE OR CONNECTION DIAGRAM.**

Line connections must be made without placing undue stress on the bushings.

Check tap changer mechanism (See Tap Changer located in the Accessory section of the booklet) to make sure that the tap changer connection is proper for the required voltage. Changes in tap connections must be done ONLY with the transformer DEENERGIZED. The transformer is normally shipped with the tap changer set for the rated voltage. Transformers equipped with an internal terminal board are shipped with the higher voltage connections unless requested otherwise by the customer.

A secure, effective low resistance ground is essential for protection. The transformer must be grounded permanently by connecting a heavy ground cable to a ground pad located at the bottom of the tank.

WARNING: **A POOR GROUND MAY RESULT IN LOSS OF LIFE OR DAMAGE TO THE EQUIPMENT.**

Pressure Test

To check the integrity of the unit, introduce *dry* nitrogen or air through the pressure test fitting until a positive internal pressure is established. Allow the tank to stand for a period of one to two hours, then examine the tank and fittings for leaks. A leak above the liquid level can be located by applying a leak check solution to all joints, pipe fittings and cable connections.

Upon completion of the pressure test, the internal pressure must be relieved from the tank.

Filling in the Field

If for any reason it was necessary to drain fluid from the transformer because of suspected damage or if the unit has been stored filled with nitrogen for a period up to three months, the problem of refilling with fluid must be considered in the light of the following circumstances.

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a. If the transformer fluid is Inerteen, no refilling should be attempted without first contacting the nearest Westinghouse Field Service Division, for environmental reasons.

b. When vacuum filling a transformer on which a Sudden Pressure Relay is mounted, *care must be taken that the Relay is not filled with liquid.* If the transformer is shipped with a dummy plate mounted in place of the Sudden Pressure Relay, the transformer should be filled with liquid before the Relay is mounted. If the Relay should accidentally be filled with liquid, it should be replaced.

Insulating Liquid Test

Test liquid as described in Maintenance Section on page 9 of this booklet. The dielectric strength for new liquid should be 26 KV or higher.

Final Inspection

Before energizing the transformer, these final checks should be made.

Electrical inspection should show that:

1. The electrical connections have been properly made (phasing, etc.).

2. The tap changer is positioned correctly.

3. All accessory contacts are operational.

4. All connections are tight and secure.

5. No grounding of the windings exists. A 1000-volt Megger test and a power factor reading should be made.

6. The correct transformer ratio exists.

7. There is continuity in all windings.

8. The neutral and ground connections have been made properly.

An external inspection is recommended to determine that:

1. Paint scratches have been refinished.

2. Bushings are clean.

3. The liquid level is proper.

4. The accessories are working correctly.

5. All tools or other objects have been removed from the transformer.

6. All handhole covers are tightly secured.

7. The mechanical relief device, when present, is reset.

8. The transformer holds pressure.

Internal inspections are normally not required. However, should one be made, the following items should be checked:

1. Evidence of moisture.

2. All bolting to assure that it is tight.

3. The tap changer linkage for operation.

4. Damage due to shifting.

ACCESSORIES

When any of the following accessories are equipped with alarm contacts, refer to the control wiring diagram referenced on the main outline drawing for contact type and terminal points. An alarm termination box is furnished on all fan-cooled transformers or when specified in the contract. One or more knockout holes, ranging in size from .88 to 1.13 inches diameter, are usually available in the sides or bottom of the termination box for customer's cable grip or conduit entrance.

Important: **When checking circuits through these instruments, it is necessary to follow Table 1. An indicating light type device is generally recognized as best for checking circuits through instruments containing micro-switches of similar capacities.**

Table 1 - Alarm Switch Ratings

Voltage	Non-Inductive Load—Amps.	Inductive Load Amps. *
125 A-C	10	10
250 A-C	5	5
125 D-C	0.5	0.05
250 D-C	0.25	0.025

*L/R equal to or less than .026.
L = Inductance in henries.
R = Resistance in ohms.

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Liquid Level Gauge

The liquid level indicator consists of a float-arm inside the tank, an indicating pointer and a magnetic coupling between the two across a liquid-tight separation. If any part of the instrument is damaged, the outer bezel may be replaced without disturbing the rest of the instrument and without loss of liquid.

The gauge may be furnished with SPDT alarm contacts to give a remote annunciation of low liquid level.

For indicators installed at the factory, the tank is filled to the level which corresponds to a liquid temperature of 25°C which is considered the normal level. Should the tank be filled at some temperature other than 25°C, use Table 2 to determine the variation above or below the normal level. If these allowances are not made, excessive pressure may be built up in sealed tanks.

Table 2

Average Liquid Temp. (°C)	Correct Filling Level (Percent of Scale Above or Below 25°C Level)
85 (High)	100
70	75
55	50
40	25
25 (Normal)	0
10	-33
-5	-67
-20 (Low)	-100

Liquid Temperature Gauge

The temperature gauge is furnished to indicate the top liquid temperature in the tank. The temperature sensitive element is mounted in a leak-proof well, permitting removal of the thermometer without lowering the liquid level. The device is furnished with an additional red pointer to show the highest temperature attained since last reset. To reset the maximum indicator, remove the attached magnet and wipe across the face of the dial.

The thermometer can be furnished with a SPST contact for fan starting and a SPDT contact for high temperature alarm. The contact settings are normally 60°C with adjustments of ± 10 degrees for contact number 1, and 90°C with adjustments of + 10, -25 for alarm contact number 2.

Pressure-Vacuum Gauge

The pressure-vacuum gauge indicates whether the gas space in the tank is under positive or negative pressure. The pressure will vary depending on barometric pressure and the liquid temperature, and it should normally be slightly positive. If the transformer is deenergized or operating under light load in low ambients, the pressure may go negative.

Note: **If the indicator reads zero and does not change under any load condition, the transformer should be checked for a possible leak in the seal.**

The unit may be equipped with a pressure-vacuum switch with two SPDT contacts for remote alarm on excesses of positive and negative pressure that could conceivably cause tank rupture or deformation. In Sealedaire applications (for oil-immersed units only), the pressure gauge is furnished in combination with a pressure regulator that will automatically bleed off gas or add make-up air to the tank if the pressure exceeds 6.5 psig positive or 6.5 psig negative. The pressure regulator is fitted with a valve and a hose fitting to take gas samples or add make-up air (or nitrogen). For further description of Sealedaire connections send for Instruction Leaflet 48-063-2.

Pressure Relief Device

Inerteen-filled transformers and all designs above 2500 KVA are normally furnished with a mechanical pressure relief device. The device is mounted on the transformer cover over a circular handhole and consists of a self-resetting, spring-loaded diaphragm and a mechanical operation indicator. Should the tank pressure increase above that for which the device is set, the gas pressure will lift the diaphragm and let the gas escape quickly. Immediately after the pressure returns to normal, the diaphragm will reset and reseal the transformer. A mechanical indicator rod will protrude vertically, which must be reset manually to indicate subsequent operation. SPDT alarm contacts may be furnished and are optional.

Winding Temperature Gauge

Transformers may be furnished with a winding temperature gauge as optional equipment. This device is also known as a Hot Spot Thermometer, to indicate the hottest spot of the transformer windings.

A temperature sensitive bimetal stem is mounted in a leak-proof well, permitting removal of the instrument and heating element without lowering the liquid level. The stem is heated by both the surrounding liquid and a heater

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element which is fed from a current source that is proportional to load current, in order to simulate the hot spot winding temperature gradient above top liquid. The combination of the two temperatures is indicated on the gauge. An additional red pointer is furnished to show the highest temperature attained since last reset and is resettable by means of a push button projecting through the bottom of the dial bezel.

Should a check on accuracy and calibration be indicated, remove the instrument from the well, temporarily detach the heater coil and immerse in a small container of insulating liquid or water. Heat the container and compare temperature indication against a good quality thermometer. For further information, send for Instruction Leaflet 48-062-10.

Contact operation and calibration may be tested by direct action or with an ohmmeter.

The gauge has four single-pole, normally open contacts with normal settings of 70, 75, 112 and 117°C. Should it become necessary to adjust any of these contacts from the above factory settings, a ± 17.5 degree adjustment is possible by turning the calibration screws located on rear of case. The calibration screws are arranged in counterclockwise order by ascending temperature with the 70 degree contact in the 5 o'clock position. Clockwise rotation of the screw increases the temperature at which the given switch will close.

TRO-2 Thermal Overload Relay

Transformers may be furnished with a Thermal Overload Relay (type TRO-2) as an optional item for the Hot Spot Thermometer when registration is required in terms of Percent Thermal Load rather than winding hot spot temperature.

The TRO-2 relay provides no continuous indication of actual winding hot spot temperatures but a related reading in terms of "Percent Thermal Load." It uses 3 single-pole, normally open contacts, the first of which is for actuation of fans when supplied.

The TRO-2 relay dial has two colored zones, one to indicate a *critical* loading condition, another to indicate an *unsafe* operating condition. Passage into the critical zone is accompanied by the closing of an alarm contact, while a tripout contact closes if the loading continues into the unsafe zone above 110% thermal load. For long and satisfactory transformer life, it is recommended that the transformer be operated at all times below 100% thermal load, with whatever margin experience shows to be advisable for anticipated rises in ambient. In that region of the dial above 80%, a change of 1°C in ambient temperature is virtually equivalent to a 1% change in thermal load.

Should a check on accuracy and calibration be indicated, consult with the factory or obtain Instruction Leaflet 48-062-17.

Caution: **Do not raise any trip switch setting above the relay nameplate temperature as this reduces the design margin of protection.**

Sudden Pressure Relay

Transformers may be furnished with a sudden pressure relay as an optional item. The sudden pressure relay is mounted on the case cover with its main pressure sensing element in direct contact with the gas cushion of liquid filled transformers. Positive operation of the bellows-actuated micro-switch occurs only in the event of an abnormal rate of rise of internal pressure and energizes a multi-contact seal-in relay fed from a separate voltage source. The relay's sensitivity is essentially unaffected by the existing static pressure in the gas space, making it sensitive to the high rates of rise that are associated with arc-producing faults in the transformer winding itself. Examples of faults detectable by this method are internal shorted turns, faults to ground or winding-to-winding. Actuation of the sudden pressure relay is not likely to occur from loose connections that produce only local heating or from bushing faults that simulate short circuits external to the case.

A seal-in relay, reset switch, and the associated circuitry is mounted in a separate control cabinet. The seal-in relay is energized when the sudden pressure micro switch operates and remains so until manually reset with the reset switch. Seal-in relay loads should be limited to the values given in the table listing given on the wiring diagram.

If field tests are required to check out the relay, consult the factory or obtain Instruction Leaflet 48-065-1.

Transformer Cooling Fans

In order to provide for greater transformer loads without overheating the windings, a set of fans will normally be clamped to the top of the transformer cooler assembly.

Fan control will be automatic from either the liquid temperature gauge, the winding temperature gauge, or a thermal relay (when furnished), in parallel with a "MANUAL-AUTO" control switch in the control cabinet. A starter contactor is used only when fan capacity exceeds the alarm switch duty rating.

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Fan motors come equipped with drain plugs on the housing to prevent collection of condensate inside the motor. When installing the fans in the field, it is important to permanently remove the bottom drain plug.

Tap Changer (See Fig. 1)

The tap changer provides a means of changing the voltage ratio of a deenergized transformer without breaking the transformer seal. It is operated by means of a rotatable handle located on the cover or side wall of the transformer. This handle is attached to the tap changer by means of a shaft which extends through the liquid and gas tight packing gland in the tank. The tap changer is normally provided with five positions, as indicated on the tap changer dial plate and transformer instruction nameplate.

DO NOT OPERATE THE TAP CHANGER WHILE THE TRANSFORMER IS ENERGIZED.

A latch pin holds the tap changer handle in any of the tap positions. By pulling this pin outward, the handle is allowed to move freely to the position desired. The latch can only be reset in the indexed boss. This assures the proper positioning. Once the tap changer latch pin is locked in position, the tap changer handle cannot be moved. For added safety, the handle may be secured in position with a padlock. Kirk Key Interlock System is optional.

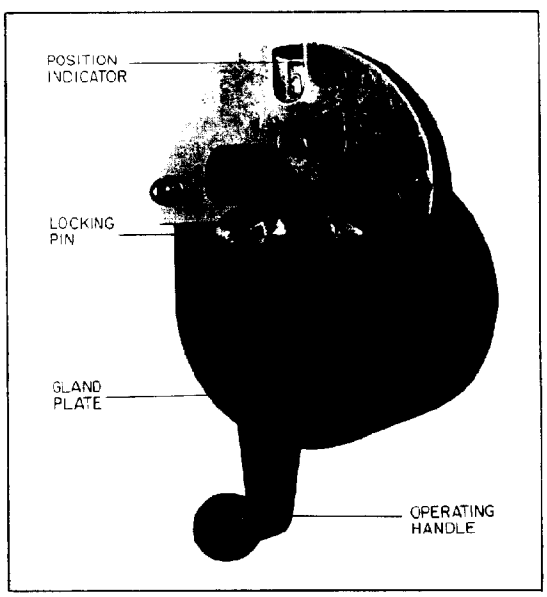

Fig. 1 *Operating Mechanism and Position Indicator*

The no-load tap changer used on most designs is an in-line type WSS consisting of an insulated framework on which three sets of six stationary contacts are mounted. Bridging the stationary contacts of each set is a self-aligning, spring-loaded, movable contact. For further details, obtain Instruction Lealfet 48-064-29.

A Type WSB-4 tap changer is used when design values exceed certain limits and is further described in Instruction Leaflet 48-064-4.

HCL Gas Absorbers (for Inerteen Transformers) (See Fig. 2)

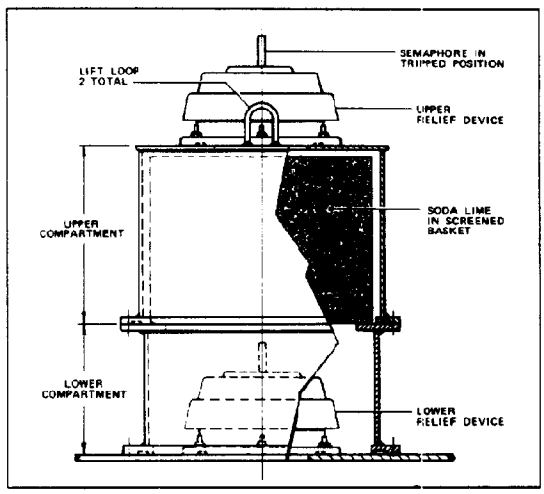

Fig. 2 *Cutaway of HCL Gas Absorber*

The HCL Gas Absorber is an optional item, used only on Inerteen indoor transformers, consisting of two air compartments and two relief devices. A basket of soda lime sets on the upper flange of the lower compartment. Installation procedures are as follows:

1. Lower compartment, which protects the lower relief device, is usually shipped in place. If not shipped in place, assemble lower compartment around lower relief device.

2. Load the screen basket with soda lime after reference to the Outline drawing for correct number of pounds, and set the basket on the top flange of the lower compartment over the lower relief device.

3. Remove blind flange from the bottom of the upper compartment and mount with upper relief device over the screen basket.

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When an arc under Inerteen generates enough pressure to operate the lower pressure relief device, the gas passes into the upper compartment and the HCL gas is absorbed by the soda lime. Residual gases are vented through the upper pressure relief device.

The condition of the soda lime is of primary importance in the maintenance of the HCL Gas Absorber. Check at periodic intervals for evidence of dampness, bluishness, or a caked condition by removing the upper relief device. These conditions require that the soda lime be replaced.

To refill the absorber:

1. Remove the upper compartment at the flange between the upper and lower compartments.

2. Clean out the basket and the absorber compartments.

3. Inspect relief devices.

4. Refill basket and relocate on upper flange of lower compartment.

5. Remount upper compartment with upper relief device over screen basket.

High Voltage Bushings (Type CR)

Winding leads for ratings 2.4 kV and up, when brought through the case end wall, use a Cast Resin Bushing. To prevent excessive mechanical loading of the bushing, only flexible connections should be made to the bushing conductor. The exposed insulating surface should be cleaned periodically to prevent accumulation of contaminating dust, dirt or chemical residue.

Care must be taken in handling the bushing to avoid cracking the resin or damaging its surface.

Should there be a need to replace an end wall bushing or gasket, it will be necessary to vent the tank to atmospheric pressure and lower fluid level to a point below the bushing opening.

When reinstalling the bushing, cement a new gasket in the gasket recess on the underside of the flange to insure that the gasket is properly seated in the groove. A 1-inch outside diameter metal washer and a lock washer should be placed between the mounting nut and the flange. After the nuts are finger-tight, each one should be tightened until the flange is .10 ± .01 inch from the surface. After completion, pressure test the transformer as described on page 4 of this booklet.

Low Voltage Bushings (Type CRW) (See Fig. 3)

Winding leads for ratings in the 1.2 kV class are normally brought through the tank wall using an indoor (or in an enclosure) type CRW bushing. This is a cast resin, hermetically-sealed bushing with a metal flange for welding to a non-magnetic steel plate on the transformer tank. Both the conductor and flange are permanently attached and sealed to the cast epoxy body.

Only flexible connections should be made to the air or liquid ends of the bushing conductor in order not to apply thermal expansion forces to the bushing. As a general rule, a maximum lateral load of 100 pounds acting at the end of the bushing conductor should not be exceeded.

For axial loads applied to the bushing connector, a maximum loading of 100 pounds is permissible. Should maintenance be required due to damage, refer to Instruction Leaflet 47-061-8, "Instructions for Weld-On, Cast Resin bushing, type CRW".

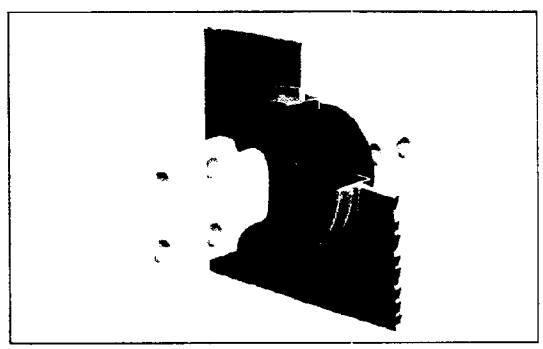

Fig. 3 *Type CRW Bushing*

MAINTENANCE

Periodic Inspection

Periodic inspections are essential to insure that the transformer gives trouble-free service. The following inspections should be done on a regular basis.

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1. Liquid Dielectric Test. It is recommended that a liquid sample be taken periodically and tested. The dielectric strength of new liquid should not drop below 26 kV as determined by the American Society of Testing Materials techniques. If the dielectric strength drops below 22 kV, the liquid should be filtered. Sampling and testing procedures can be found in Instruction Book 45-063-100 for oil and Instruction Book 45-063-99 for INERTEEN.

2. Check all gauges. The liquid, depending on the temperature, should be at the proper level. Low liquid level can affect the transformers's ability to cool itself and can expose "live" parts causing flashover to ground or other "live" parts. The maximum temperature indicator should be checked to see that the liquid temperature is operating within normal limits.

3. Check the tank for leaks. Inspect and tighten all bolted joints.

4. The paint finish should be checked periodically. (See "Finish" on page 12 of this booklet.)

5. Switch Operation. (See Switch Section II of this booklet.)

Sampling of Insulating Liquid

Care should be taken to procure a sample which fairly represents the liquid in the tank. A sufficient amount of liquid should therefore be drawn off before the sample is taken to insure that the sample will not be that which is stored in the sampling pipe. If the sample taken contains free water, it is not suitable for dielectric test and the sample should be discarded. A second sample should then be taken after at least two quarts of liquid have been withdrawn. If free water still exists, the liquid should be run through a blotter filter press and re-tested for dielectric strength.

The sample of the liquid should be taken when the unit is warmer than the surroundings to avoid condensation and should also be taken only on clear days.

When sampling *OIL* from the transformer, the sample must come from the bottom of the tank. It is recommended that a 16-ounce amber glass container be used as a sampling receptacle so that any water present may readily be seen.

When sampling *INERTEEN* the sample must come from the top liquid level. Use only tin containers with screwed metal caps or glass bottles with Inerteen-resistant stoppers. Always use all-metal hose or pipe when handling Inerteen.

Caution: **Inerteen is a skin irritant. Unnecessary contact with the liquid or its vapor, particularly when hot, should be avoided. The eyes, nose and lips are affected when Inerteen comes in contact with them. All safety precautions must be observed when handling Inerteen.**

Additional Information

Additional information concerning handling, sampling, filtering, testing, and reconditioning can be obtained by ordering Instruction Book 45-063-100 for OIL and Instruction Book 45-063-99 for INERTEEN through the nearest Westinghouse Sales Office.

Disposal of Inerteen

See American National Standards Institute Guidelines C107.1-1974 for complete information on handling and disposal of Askarels. Copies are available from: ANSI, 1430 Broadway, New York, N.Y. 10018.

Collect all scrap Inerteen liquid in a suitable metal container which can be satisfactorily sealed. Once the Inerteen is collected, it may be returned in sealed drums or tank cars to Monsanto or other certified disposal company. Ship prepaid to:

Monsanto Company
W. G. Krummrich Plant
Sauget, Illinois
Attn: Supervisor Dept., 246

Nuclear Engineering Co.
Disposal Division
Sheffield, Illinois

Chem-Trol Pollution Serv., Inc.
4818 Lake Avenue
Blasdell, N.Y. 14219

Rollins-Purle, Inc.
Box 3349
Wilmington, Del. 19899

A charge will be made for all returned Inerteen.

Solvent rinses or other liquids contaminated with Inerteen should also be collected in sealed drums or tank cars and sent either to Monsanto or other certified disposal company.

All solids materials contaminated with Inerteen must be stored in impervious containers until disposal. This includes all glass, metals, papers, insulation, clay rags, filter cartridges, etc.

These materials may be incinerated if suitable arrangements can be made for it to be done at a temperature sufficient to breakdown the Inerteen. Or they may be purged by cleaning with a proper fluid and the resultant fluid then may be incinerated using an approved procedure and temperature.

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The following disposition is recommended for various materials.

Material	Disposition
Absorbing clay, filter paper, cartridges, sawdust and rags	Incinerate
Coils	Solvent Clean or Incinerate
Cores	Solvent Clean
Tanks & Frames	Solvent Clean
Copper or Aluminum	Solvent Clean
Insulation	Incinerate

Incineration

Incineration, whether of liquids or contaminated solid materials, must be done at a temperature of at least 2250°F and the stack must be equipped with a suitable scrubber to remove HCl.

Cleaning

The cleaning of drums which have contained used Inerteen requires great care in order to insure a thoroughly clean drum.

It is preferable to return such drums to the supplier where adequate cleaning facilities are available, rather than to attempt to clean them.

If it is necessary to clean such drums, the following procedure is recommended:

Rinse the drum thoroughly with gasoline or petroleum distillate, using about one gallon each time, until the solvent shows no discoloration after using. Allow it to drain, then pump out the last traces of solvent with a vacuum pump, using a brass pipe flattened at the lower end to explore the corners of the drum. Collect all solvent rinse material for disposition as described above.

Caution: **Do not use a steel pipe because of the danger of a spark igniting the gasoline or petroleum distillate vapor.**

Next, heat the drum with bunghole down in a ventilated oven at a temperature of at least 88°C. (190°F) for sixteen hours. (A simple oven for this purpose may be made from sheet metal and heated with steam or an electric heater.) Blow out the drum with dry nitrogen or dry air to remove any lingering explosive vapors. Screw the bung on tightly before removing the drum from the oven. Use a new washer with the bung to insure a tight seal.

Caution: **Open flames must always be kept away from the oven to prevent igniting inflammable gases which might be remaining in drum when placed in the oven.**

The practice of refilling drums with Inerteen is undesirable and should be avoided whenever possible, for unless the utmost precautions are taken, the Inerteen is likely to become contaminated.

Drying of Transformer

Occasionally, moisture will be absorbed in the windings and insulation which the filtering process will not remove. A recommended method of drying the windings and insulation is by circulating current through the windings. The LV winding should be short-circuited and sufficient voltage impressed across the high voltage winding to circulate enough current through the coils to maintain the coil temperature at 80°C to 90°C as measured by winding resistance. About one-fifth of normal full-rated current is generally sufficient to do this. The impressed voltage necessary to circulate this current varies within wide limits among different transformers. This voltage will generally be approximately 1/2 percent to 1-1/2 percent of the normal voltage of the winding at normal frequency.

The transformer should be placed in its case with the liquid and with the handhole cover removed to allow free circulation of the air in the gas space.

For complete information on determination of dryness and additional methods of drying out, order Instruction Leaflet 48-620-1.

Vacuum Filling of Transformer

In order to obtain the vacuum levels specified and to maintain these levels during liquid filling, a good vacuum pump of adequate capacity will be needed. A 100 CFM pump will be adequate. The pump should be capable of obtaining a blank-off pressure of .02 TORR or less for 15 psi or full vacuum tank.

The transformer instruction nameplate gives the design tank pressure. Using this pressure and Table 3, the re-

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quired vacuum and holding time can be determined. The vacuum should be measured above the liquid level location.

Before filling, a sample of the liquid should be tested for dielectric strength. See "Sampling of Insulating Liquid" Section on Page 10 of this booklet.

It is recommended that the liquid temperature be $10^{o}C$ or higher during vacuum filling. The temperature of the core and coil must be above $0^{o}C$.

The liquid should be pumped into the tank through a filter press.

Table 3 – Vacuum Treatment and Liquid Filling

	15 P.S.I. or Full Vacuum Tanks	
Condition	**Absolute Pressure in Tank Torr**	**Vacuum Holding Time Hours**
Before Filling	5 Maximum	4
During Filling	6 Maximum	-
After Filling	5 Maximum	2
	8 P.S.I. Tanks	
Before Filling	347 Minimum	4
During Filling	347 Minimum	-
After Filling	347 Minimum	2
	5 P.S.I. Tanks	
Before Filling	502 Minimum	4
During Filling	502 Minimum	-
After Filling	502 Minimum	2

Note: 1 Torr = 1 mm Hg = .0193 P.S.I.

Caution: Where "MINIMUM" is specified lower pressures may result in tank damage or permanent deformation with serious damage to internal parts.

Gaskets

All gaskets used on Substation Transformers are normally made of Cortite, a gasket material consisting of cork and synthetic rubber; and for satisfactory results replacement gaskets should be of the same material. Before replacing a gasket, carefully and thoroughly clean the steel surfaces between which the gaskets are compressed to remove rust, oil, grease, paint and other foreign material. The cleaning may be done by scraping or wire-brushing and then wiping the gasket surface with de-natured alcohol. Use gasket cement 53351GH when applying gaskets. Put the gasket in place and bolt the two surfaces together under uniform pressure. After the unit has been in service for a period of six months, retighten all the bolts.

Finish

Instructions for refinishing transformer are as follows:

1. If the paint on the unit is generally firm and sound, it is not advisable to strip the entire surface.

2. All rusted areas should be thoroughly wire-brushed, sanded, etc., to remove all rust, loose paint, etc.

3. Thoroughly wipe down with solvent-soaked rags to remove all dirt, oil, abrading dust, etc. Sometimes it is advisable to give the unit a light blasting using sand, ground corn cob or grounded walnut shell to roughen up the surface.

4. Apply by brush method a coat of fast-dry primer 32230DU to all areas abraded to base metal; then follow with a complete spray coat of the fast-dry primer.

5. Allow to air dry overnight or apply moderate heat of 65^{o} to $75^{o}C$ for several hours.

6. After the primer coat is thoroughly dried, then apply a heavy, uniform spray coat of air dry enamel in the desired finish color.

7. Allow to air dry for at least 24 hours before placing back in service. Moderate heat of 65^{o} to $75^{o}C$ for several hours is preferable if available.

8. Should extra protection be desired, then a second coat of the finish enamel can be applied.

Additional Maintenance Instructions

The following are additional instructions that may be useful in maintaining the Substation Transformer. These leaflets may be obtained through the nearest Westinghouse Sales Office.

Removing and Replacing Welded-On Covers . . . . . I.L. 47-600-21
Instructions for Repairing Tank Leaks . . I.L. 48-069-20
Cleaning Transformer Insulation . . . . . I.L. 48-069-13

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SECTION II. INTERRUPTER SWITCHES AND FUSES

MOLDED POWER SWITCH

General Description

The molded power switch is a three-pole, air-insulated, current interrupter switch. The switch is designed to be manually operated to interrupt load currents of 600 amperes at 15 kV, to close on fault current of 40,000 amperes and withstand 61,000 amperes RMS asymmetric at 15 kV. It has a full wave impulse rating of 95 kV. The design requires mounting within a metal cubicle, as pictured in Fig. 4.

Power Switch Component

(Molded Epoxy Case) - The switch blades and interrupting arc-chutes are enclosed by an epoxy case and polycarbonate covers.

(Main Blades and Contacts) - The main blades are copper with the contact ridge formed in one end.

(Load Interrupter) - These are comprised of a quick-break blade, torsional spring and arc-chute.

(Operating Mechanism) - The operating mechanism consists of a power spring connected to the crank.

Cubicle Construction

The power switch is mounted on the upper segment of a vertical steel barrier plate, dividing the high voltage incoming cubicle into two parts. The rear part, known as the termination compartment, houses any lightning arresters, potheads, or other cable entrance fittings associated with the incoming primary circuit. A bolted-on steel panel at the rear of the cubicle allows access to this compartment for making the initial primary cable connections.

Caution: **ONCE THE LINE CONNECTION IS MADE AND THE SWITCH TERMINALS ARE ENERGIZED, THIS REAR ACCESS PANEL MUST REMAIN CLOSED TO PREVENT ACCIDENTAL CONTACT WITH LIVE PARTS.**

The cable entrance to the termination compartment is normally through either:

1) Wiping sleeves
2) Packing glands (stuffing boxes)
3) Potheads or terminators

The type cable used is the key to the kind of connection required. The cable dictates the stress cone used and entrance fitting required.

Important: **Refer to the cable manufacturer for stress relief cone requirements.**

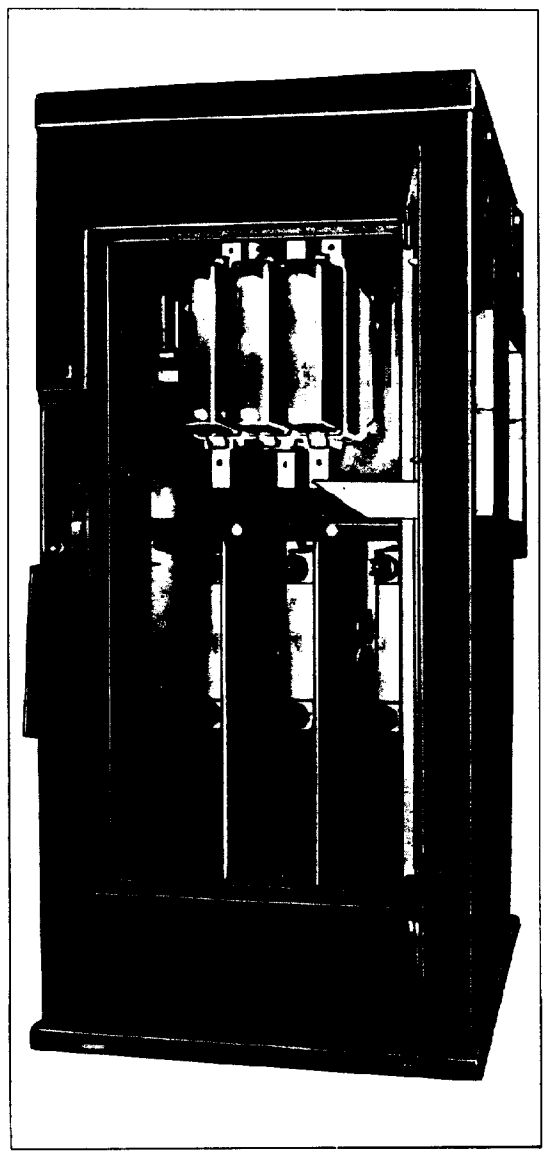

Fig. 4 *Molded Power Switch*

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The front compartment houses the switch itself plus any power fuses that are required between the switch and the transformer primary bushings. The switch terminations are connected by copper cable through a throat transition to the bushings of the transformer. Access to the switch and fuse compartment is afforded by a hinged door at the front of the cubicle, which is mechanically latched to prevent opening the door when the switch is closed. The switch design also prevents closing of the switch with the door open. When required, a Kirk key interlock is added to the switch mechanism and made accessible through the same access door that permits removal of the switch operating handle. Through coordination with the low voltage switchgear section, this interlock can prevent any operation of the switch if the low voltage circuit is closed.

In the case of a Duplex Molded Switch design, a second cubicle adjoins the original cubicle to provide a switching arrangement per Fig. 5 below. Front hinged doors are interlocked to prevent opening either door when either switch is in the closed position. Normal key interlocking also prevents having both switches closed at the same time.

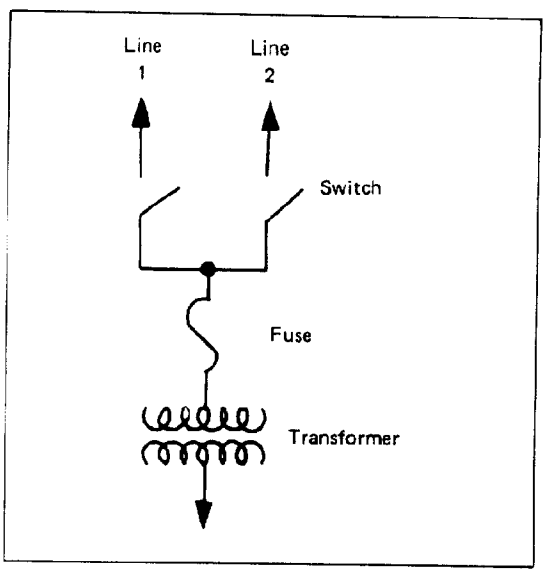

Fig. 5

Operations

With the switch in the closed position, the current flows in the main blades. For operations, the small operating mechanism access door must be unlocked and the operating handle removed. Insert the socket of the handle over the operating shaft of the mechanism. By moving the handle in the desired direction, the power spring is stretched until a certain point is reached. At this time, the stored energy of the spring releases the operating handle and snaps open the main contact blades. The current continues to flow in the quick-break blade until a predetermined position of the main blade is reached. At this point, the torsional spring at the pivot snaps open the quick-break blade. The arc drawn within the arc-chute is quickly extinguished by the heat of the arc releasing a blast of de-ionized gas from the gas generating material within the arc-chute, and the high speed of the blade by combination of the main blade speed and rotation by the torsional spring. Closing operations are similar with quick-break and main blades making initial contact on silver-tungsten contacts.

Storage and Handling

If prolonged storage is necessary, steps should be taken to maintain the inside temperature level above that outside the switch cubicle in order to prevent condensation on vital insulation parts. Outdoor type switch designs normally include a 500 watt space heater within the switch enclosure. Indoor type designs are equipped with a space heater only when specifically requested.

When conditions dictate that the Power Switch component be shipped separate from its cubicle, it should be stored in its original packing case, protected from weather, dust, and other adverse conditions. Care should be taken when unpacking the switch to prevent damage.

Installation

Molded power switches are shipped separately from the transformer itself and must be moved into place on the foundation next to the transformer using lifting holes available at the top of the switch cubicle. The connection between transformer throat and switch throat is made weatherproof by a sealing-ring clamp arrangement, shipped as a detail part. The switch cubicle should be grounded permanently to the system ground bus by connecting a cable to the external ground pad. Cable attachment to the transformer bushings is a bolted connection using terminals already attached at the end of the switch cable assembly. Access to this connection is through a removable handhole cover atop transformer high voltage wall-mounted throat.

Prior to energization, the Molded Power Switch assembled parts should be carefully cleaned of all internal dust and dirt accumulation. Special attention should be given to cleaning the porcelain insulators, connecting cables,

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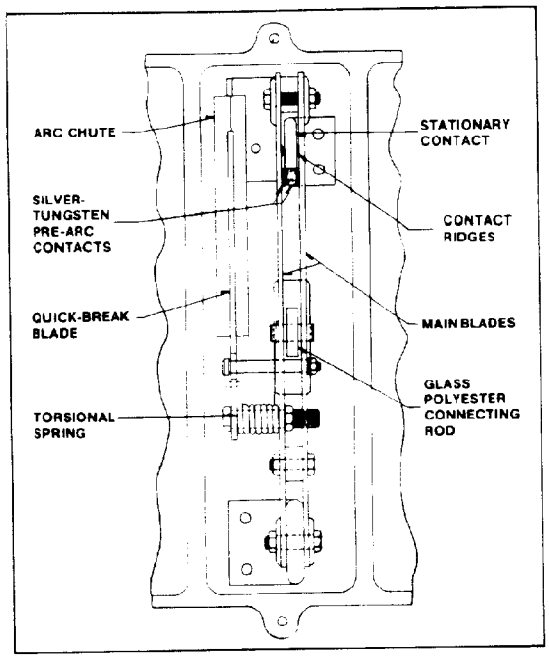

Fig. 6 *Main Blade and Quick-Break Blade*

cable guides, switch contacts, interruption chambers and blades.

Adjustments

Each switch has been adjusted and tested at the factory. Additional adjustments should not be necessary. However, the following inspections may be made to insure adjustments have not been altered during shipment and handling.

a. To assure contact along the entire length of the contact ridge in the main blades, a 2-mil feeler gauge shouldn't slip between the main blades and the stationary contact.

b. Adjust contact pressure on both ends of the main blades by tightening the bolts .75 turn past the position where play is eliminated.

c. Before tightening the mounting bolts of blade assembly, main contact and arc-chute, adjust alignment to assure that all parts close and open smoothly. It is recommended that the connecting rods be disconnected for this operation.

d. Adjust the adjusting bolts in the stop so that, with the switch open, the tip of the main blades extend 13.25 inches from the epoxy mounting surface; and closed, the blades are 1.06 inches above the epoxy mounting surface.

e. At least two no-load operations of the mechanism should be made to insure smooth operations of the switch.

MAINTENANCE

Inspection and Cleaning

It is recommended that the switch be inspected at a minimum of each 50 current interruptions or once a year, whichever occurs first. The epoxy case, arc-chute, quick-break blade, and main blade should be cleaned of dust or any foreign material which might be deposited on them. The contact ridge on the main blades should not be filed or abraded, which could cause excessive wear and perhaps galling on the stationary contact.

The quick-break blade should be inspected to determine if excessive carbon, damage or blade misalignment has occurred to either the blade or the silver-tungsten contacts. If either is damaged, the arc-chute should be assumed to be damaged; therefore, both the arc-chute and the quick-break blade should be replaced. If excessive carbon deposits are found, replace the arc-chutes. Misalignment may be corrected by slightly bending the blade back into its original position so that the blade strikes the slit in the arc-chute. The torsional spring at the pivot of the blade should be inspected to determine if it is broken. If it is broken, it must be replaced before the switch is placed in service.

The stationary contacts, pre-arc contacts, main blades, and contact ridge should be inspected for damage or misalignment. If damage has occurred, the part should be replaced. If misalignment is discovered, disconnect the glass-polyester connecting rod, loosen and move stationary contact in line with the blade. Tighten the stationary contact bolts and connect the connecting rod.

Inspection of the glass-polyester connecting rod should be made around the pins. If cracks or breaks are found, the rod must be replaced.

The mounting bolts should be inspected to determine if vibration has loosened them. They should be tightened until they hold the switch firmly in place.

When inspections are complete, refer to "Adjustments" on this page.

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Replacement Schedule

It is recommended that the main blades, arcing blades, arc-chutes and stationary contacts be replaced at the completion of 500 operations because of mechanical wear. The periodic inspection suggested in "Inspection and Cleaning" may indicate replacement of certain parts prior to this mechanical limit because of varying service and environmental conditions.

When replacement is made, refer to "Adjustments" in this section, page 15.

TYPE LBF SWITCH

A limited number of units will be designed using a type LBF Interrupter Switch, having the same electrical characteristics as the Molded Power Switch described above. When information is required on this type of switch, reference should be made to Instruction Leaflet 47-066-18, obtainable from the nearest Westinghouse Sales Office.

FUSES

Fuses when required will be of the expulsion type, or the current-limiting type. Fuses are only accessible through the front hinged interlocked door of interrupter switches and may be replaced per instructions below. Should further descriptive information be needed, send for Instruction Leaflet 47-069-8.

Expulsion Type

1. Lift fuse holder straight out from fuse clips.

2. With refilling tool unscrew condenser at bottom of fuse holder.

3. Unscrew cap and unlatch spring, allowing refill to slide out.

4. Screw the refilling tool into latch end of spring. Screw spring and new refill firmly together by hand. Do not use a wrench.

5. Slide this assemby back into the fuse holder.

6. Stretch and latch spring. Remove refilling tool.

7. Screw cap in place and tighten.

8. Tighten condenser using refilling tool.

9. Place fuse holder firmly back into fuse clip mounting.

Current-Limiting Type

For these fuses, the whole unit must be replaced. On fuses rated 2500 volts and above, a red plastic indicator projecting below the ferrule gives ready indication that the fuse has operated.

SECTION III. RENEWAL PARTS

Order renewal parts from the nearest Westinghouse Sales Office, giving description of parts wanted, as well as the serial number on the transformer nameplate. A renewal parts list can be obtained in the same manner.

In order to expedite maintenance, the parts listed on the Recommended Parts List should be stocked by the user.

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